

Withered by Jack. Bent

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MASTER OSCILLATOR

THE FOLLOWING PAGES ARE FOR
MISCELLANEOUS PURPOSES
AND HAVE BEEN DONE BY ME
OVER THE PAST 3 MONTHS

TODAY IS DEC. 29, 1961

Jefferson, N.Y.

60518307

THE CLOCK OR MASTER OSCILLATOR, IS A ~~STABLE~~,
VARIABLE-FREQUENCY WAVEFORM GENERATOR

~~THE OUTPUT OF THE CLOCK~~

THERE ARE TWO SIGNAL OUTPUTS OF THE CLOCK
OR MASTER OSCILLATOR. ONE IS A SQUARE WAVE $\square\square\square$,
~~THE OTHER~~, A SINE WAVE. $\sim\sim$. THE OUTPUTS ARE
~~AT THE EXACT SAME FREQUENCY~~

THE FUNCTION OF THE CLOCK IS TO FURNISH THE
"DRIVING-SIGNALS" TO THE DEVICE. IT IS ALSO
A MEANS BY WHICH THE ^{INNER} WORKINGS OF THE DEVICE
ARE "TIME-SYNCHRONIZED."

WE REFER TO THE OUTPUT OF THE CLOCK AS
"HIGH FREQUENCY," ~~FOR~~ BECAUSE WE COUNT
DOWN (BY MEANS OF A COUNTER TO BE DESCRIBED
LATER) TO THE "FRAME FREQUENCY", ~~OR~~ ~~THUS~~ ^{OR PICTURE}
ESTABLISHING A FRAME RATE. FRAME RATE IS THE
RATE AT WHICH WE DRAW ONE COMPLETE FIGURE ^{ON}
THE DISPLAY SCOPE.

BECAUSE THE COUNTER PERFORMS A FIXED-RATIO-
COUNTDOWN, THE LOW FREQUENCY IS ALWAYS
A LOWER MULTIPLE OF THE HIGH FREQUENCY.

THUS, BY VARYING THE HIGH FREQUENCY, WE AUTOMATICALLY
VARY THE LOW FREQUENCY OR FRAME RATE.

DURING THIS DEVELOPMENTAL PERIOD, WE ^{HAVE BEEN} OPERATING
AT FRAME RATES BETWEEN 24 AND 30 CYCLES PER
SECOND (CPS). 30 CPS IS DESIRABLE AT THIS TIME BECAUSE
a.) THE LIGHTING IN OUR WORKSHOP IS SUCH THAT AT A LOWER
FRAME RATE, WE SEE A BOthersome FLICKER, and
b.) IT IS VERY EASY TO SYNCHRONIZE THE FREQUENCIES
TO ^{WITH A HAND ADJUSTMENT} THE 60-CYCLE LINE FREQUENCIES (JUST TWICE THE
FRAME RATE) AND THEREBY ELIMINATE WHAT IS KNOWN
AS "HUM" OR LINE NOISE, WHICH IF NOT SYNCHRONIZED
CAUSES A SLOW WOBBLE OF THE PICTURE.

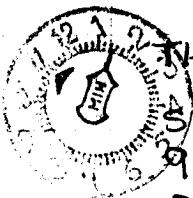
IN THE FUTURE, WE WILL INSTALL A FEEDBACK TIMING
CONTROL IN THE COUNTER CIRCUIT WHICH WILL AUTOMATICALLY
SYNCHRONIZE ALL FREQUENCIES TO THE LINE (60 CPS) AND

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Leekkarsin TW

THUS ELIMINATE THE NECESSITY OF HAND ADJUSTMENTS
AND ALSO ASSURE AN EXACT 24 CPS FRAME RATE.

THE SQUARE WAVE OUTPUT IS FED DIRECTLY INTO
THE COUNTER. IT IS ALSO ^{FED INTO AND IS} THE DRIVING SIGNAL
FOR THE HORIZONTAL DEFLECTION GENERATOR OF THE
SKIN SCANNER (TO BE DESCRIBED LATER.)



THE SINE WAVE OUTPUT IS FED INTO TWO OF THE
SAMPLERS (SAMPLER GATES) ~~ARE~~ ^{TO BE DESCRIBED LATER} ALSO INTO A
90 DEGREE PHASE SHIFTER WHOSE OUTPUT NOW
BECOMES A COSINE WAVE (IN RELATION TO THE
~~ORIGINAL~~ ^{DEC 2 1965} SINE WAVE) ~~ARE~~ WHICH IS SUBSEQUENTLY
FED INTO THE OTHER SET OF SAMPLERS. ALSO
BOTH SINE AND COSINE WAVES ARE FED INTO
MODULATORS (TO BE DESCRIBED LATER)

THE FUNCTION OF THE CLOCK MAY BE TAKEN OVER
BY THE TAPE RECORDER, WHERE THE CLOCK SIGNALS
ARE RECORDED ON ONE OF THE CHANNELS, AND
USED AS DRIVING SIGNALS OF THE DEVICE, THUS
SYNCHRONIZING ALL RECORDED SIGNALS ~~ARE~~ WITH
THE "TAPE CLOCK".

Aug 3

Lee Garrison M

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COUNTER & TIMING CONTROL

Written by [unclear]
L.C. [unclear]

CNT
L.C.
12 [unclear]

THE COUNTER IS A CHAIN OF BISTABLE MULTIVIBRATORS. THE INPUT TO THE FIRST BSMV IN THE CHAIN IS THE HIGH FREQUENCY SQUARE WAVE FROM THE CLOCK. THE OUTPUT OF THE FIRST BSMV IS A SQUARE WAVE WHICH IS EXACTLY $\frac{1}{2}$ THE FREQUENCY OF THE INPUT. THIS EACH BSMV IN THE CHAIN HALVES ITS INPUT FREQUENCY.

AT THE PRESENT TIME WE HAVE 9 BSMV'S IN THE COUNTER CHAIN. THIS GIVES A COUNTDOWN RATIO OF 512:1. THUS FOR A FRAME RATE OF 24 FRAMES/SEC, THE HIGH FREQUENCY MUST BE 12,288 CPS.

THERE IS NOTHING MAGIC ABOUT THIS SELECTED RATIO OF 512 TO 1. THE CHOICE OF IT AT THIS TIME WAS GOVERNED BY THE EASE WITH WHICH WE ARE ABLE TO USE THE HIGH FREQUENCY IN THE FUNCTION (SINE-COSINE) GENERATOR NETWORK.

IF THE FREQUENCIES USED IN THAT NETWORK GET TOO HIGH, THE GENERATOR DOES NOT PERFORM AS WELL AS WE'D LIKE IT TO. WE HAVE NOT HAD TIME TO ~~RE~~ DESIGN THE NETWORK. HOWEVER IT WORKS WELL UP TO 16 OR 17 KC, EASILY ALLOWING A 30 FPS FRAME RATE.

OF COURSE, THE HIGHER ^{THE} FREQUENCY WE USE, THE GREATER "BONE & SKIN" RESOLUTION WE MAY HAVE (THIS WILL BE EXPLAINED LATER.)

THE OUTPUT ~~OF~~ OF THE FIRST BSMV, ~~IS~~ BESIDES BEING FED INTO THE 2nd BSMV, IS ALSO FED INTO THE DELAY MULTIVIBRATORS IN THE AFORE-MENTION SINE-COSINE FUNCTION GENERATOR NETWORK, AND ACTS AS A DRIVING SIGNAL FOR THOSE DELAY MVS. IN OTHER WORDS, IT ~~CAUSES~~ THE DELAY MVS TO ~~ALLOW~~ A SAMPLING OF THE SINE-AND COSINE ~~WAVES~~ WAVES IN THE SAMPLERS AT $\frac{1}{2}$ THE FREQUENCY OF THE SINE-& COSINE WAVES IN THE SAMPLERS, WHERE ARE 2 CYCLES ~~TO~~ TO SAMPLE FROM,

OF THE COUNTER, WILL PRODUCE 24 CPS (AS ACCURATELY AS THE LINE FREQUENCY IS 60 CPS) AT THE BACK END BY A MOTOR SPEED GOVERNOR, WHICH WOULD ACCURATELY REGULATE THE TAPE SPEED, AND THIS THE FREQUENCIES COMING OFF THE TAPE.

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Detarium Jr

THE SIGNIFICANCE OF THIS IS THAT WE CAN GET MORE THAN A 360° ROTATION ~~OF~~ A BONE. (TO BE DESCRIBED MORE FULLY)

THE TIMING CONTROL IS A FEEDBACK NETWORK WHICH SYNCHRONIZES ~~ALL OF~~ DRIVING FREQUENCIES (ie HIGH & LOW) TO THE 60 CPS LINE-FREQUENCY, THUS ~~ASSURING AN EXACT 24 FPS FRAME RATE,~~

~~HUM: THE ELECTRONIC EQUIPMENT OPERATES BY POWER RECEIVED FROM A 60-CYCLE SUPPLY LINE. THIS POWER AT 60 CPS IS PRESENT IN WIRES AND CABLES NEAR & THRU THE EQUIPMENT, AND HAS A TENDENCY TO RADIATE A CERTAIN AMOUNT OF THIS POWER TO ADJACENT PARTS. THE RESULT IS THAT THERE IS ALWAYS PRESENT A SLIGHT VOLTAGE RIPPLE ON THE LINES, IN THE AMPLIFIERS, AND EVEN IN THE D.C. REGULATED-VOLTAGE SUPPLIES. THIS MAY BE ELIMINATED BY ~~SHIELDING AND FILTERING~~ OF THE SUPPLIES, OR IT MAY BE COMPENSATED FOR BY SYNCHRONIZING ALL OF THE ^{OPERATING} FREQUENCIES ^{AN EVEN MULTIPLE OF} THIS HUM. FOR EXAMPLE, LET US SUPPOSE WE ARE OPERATING AT 23.999 FRAMES PER SECOND, AND THE LINE RIPPLE IS AT 60 CPS. THE PICTURE WILL TEND TO SLOWLY UNDULATE BECAUSE OF A BEAT SET UP BY THE TWO, NON-MULTIPLE FREQUENCIES. HOWEVER, BY MAKING THE FRAME RATE EXACTLY 24 FPS, WE WILL DRAW ~~A~~ COMPLETE FRAMES FOR EVERY ~~2~~ CYCLES OF HUM.~~

~~FOR EXAMPLE~~

THERE ARE 2 INPUTS TO THE TIMING CONTROL: ONE IS THE ^{POWER} 24 CPS FROM THE COUNTER, THE OTHER IS 60 CPS FROM THE LINE. THE 24 CPS FRAME RATE IS FED INTO A BSMV WHOSE OUTPUT IS THEREFORE 12 CPS. THE LINE FREQUENCY (60 CPS) IS FED INTO A 5:1 COUNTER (BINARY FEEDBACK TYPE) AND ITS OUTPUT IS 12 CPS. THESE 2 FREQUENCIES ARE THEN FED INTO A PHASE-COMPARATOR. THE OUTPUT OF THE PHASE COMPARATOR (A D.C. VOLTAGE) IS FED INTO A D.C.-CONTROLLED OSCILLATOR WHOSE MEAN OUTPUT FREQUENCY WILL BE THE ~~REQUIRED~~ HIGH FREQUENCY WHICH WHEN FED INTO THE FRONT END OF THE

BONE GENERATOR

Lee Garrison

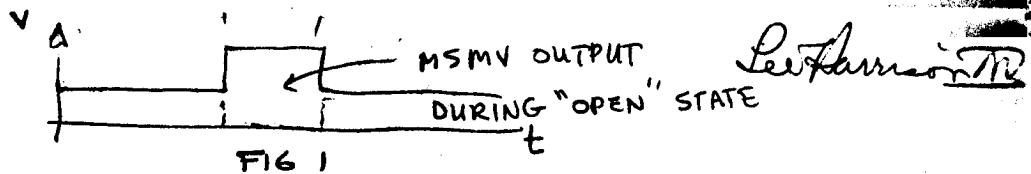
ELECTRONIC GATE-COMMUTATOR OR MONOSTABLE MULTIVIBRATOR CHAIN

THE CHAIN OF ~~MONOSTABLE~~ MONOSTABLE MULTIVIBRATORS ~~IS~~ IS AN ELECTRONIC COMMUTATOR WHICH OPENS AND CLOSES A SERIES OF "BONE" GATES IN A SEQUENTIAL MANNER. IN OTHER WORDS, THE MSMV'S FURNISH THE DRIVING (OPENING & CLOSING) SIGNALS TO THE GATES.

THE INPUT TO THE FIRST MSMV IN THE CHAIN IS A FRAME-RATE PULSE (SAY 24 CPS) WHICH COMES FROM THE COUNTER. WHEN THE PULSE ARRIVES, IT CAUSES THE MSMV TO FLIP INTO ~~THE~~ ITS OTHER (UNSTABLE) STATE, FOR A LENGTH OF TIME AS DETERMINED BY ITS INTEGRAL RC NETWORK. BY VARYING R, THE LENGTH OF TIME DURING WHICH THE MSMV IS IN ITS UNSTABLE STATE MAY BE VARIED. ~~WHEN THIS TIME HAS LAPSED~~, THE DURING THIS "OPEN" TIME, A CHANGE IN VOLTAGE OCCURS ON ONE OF ITS OUTPUTS. THIS VOLTAGE IS USED TO OPEN A NUMBER OF GATES CONNECTED TO IT. WHEN THE "OPEN" TIME HAS LAPSED, THE MSMV AUTOMATICALLY FLIPS BACK INTO ITS ORIGINAL STATE (STABLE), AND CHANGES BACK THE OUTPUT VOLTAGE DRIVING THE GATES, THUS CLOSING THEM. DURING THE FLIP-BACK, A PULSE SIMILAR TO THE ONE THAT CAUSED THE ORIGINAL FLIP IS GENERATED AT ANOTHER OUTPUT POINT, AND THENCE IS SENT TO THE NEXT MSMV IN THE CHAIN WHERE A SIMILAR OPERATION OCCURS, THUS OPENING THE NEXT GROUP OF ASSOCIATED GATES FOR ²_{nd} A TIME DESCRIBED BY THE R ASSOCIATED WITH THAT ²_{nd} MSMV. THIS COMMUTATING ACTION CONTINUES UNTIL ALL THE MSMV'S IN THE CHAIN HAVE GONE THRU THEIR INDIVIDUAL CYCLES.

THE "DRIVING OUTPUT" OF THE MS(MV)'S (SHOWN IN FIG 1.) IS USE TO PERFORM A NUMBER OF TASKS. FOR EXAMPLE, THIS OUTPUT MAY BE USED TO CLOSE THE ELECTRONIC SWITCHES ACROSS THE

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INTEGRATING CAPACITORS, THUS CAUSING THE DISPLAY BEAM TO "FLY BACK" TO ITS STARTING POINT. ~~THESE SIGNALS ARE USED THEREFORE AS INPUTS TO THE FLYBACK CIRCUIT,~~ AND THIS ACTION WILL BE DESCRIBED LATER IN MORE DETAIL. ANOTHER USE OF THE MSMV OUTPUT IS TO DIM OR BLANK-OUT THE DISPLAY BEAM. BY APPLYING THE MSMV OUTPUT TO THE GRID OF THE DISPLAY CRT, THE BEAM IS "TURNED OFF" DURING THE "OPEN" TIME OF THE MSMV SO ENGAGED. IN THIS MANNER, FLYBACK RETRACES, AND CERTAIN BONE-PLACING RETRACES - (AS IN THE ARMS, WHERE THE BEAM MUST MOVE FROM THE STARTING POINT, UP TO THE SHOULDER AND THENCE PROCEDE TO DRAW THE ARM, AND DURING THAT "PLACEMENT" BONE DRAWING, THE BEAM IS BLANKED OUT) MAY BE BLANKED OUT AS ~~REQUIRED~~.

AS MENTIONED BEFORE, THE LENGTH OF TIME THAT AN MSMV REMAINS IN ITS OPEN POSITION IS DETERMINED BY R OF THE INTEGRAL RC NETWORK. THUS BY VARYING EACH OF THE RESISTANCES ASSOCIATED WITH EACH MSMV-RC-NETWORK, AN OPERATOR IS ABLE TO "SET-UP" A FIGURE OR CHARACTER TO HAVE THE DESIRE "BONE" LENGTHS, AND OVERALL STRUCTURE. HE ALSO, IN THIS SETUP PROCEDURE, DETERMINES THE SEQUENCE IN WHICH THE PARTICULAR BONES WILL BE DRAWN. IN DETERMINING THIS SEQUENCE HE MAKES THE NECESSARY CONNECTIONS ~~BETWEEN THE MSMV'S AND~~ THE FLYBACK ~~CIRCUIT~~, BLANKING CIRCUIT IN ADDITION TO DETERMINING ~~AND~~ SETTING UP THE DESIRED BONE LENGTHS.

THE MSMV CHAIN IS A SWITCHING, COMMUTATING NETWORK WHICH REGULATES THE OPENING AND CLOSING OF THE "BONE" GATES, ~~THE~~ THE VARIOUS TASKS WHICH IT PERFORMS COULD BE DONE IN OTHER WAYS, SUCH AS (a.) MECHANICAL SYSTEMS (b.) BINARY COUNTER SYSTEMS WITH AND/OR DIODE NETWORKS (c.) OTHER ELECTRONIC ARRANGEMENTS (d.) ELECTRO-MECHANICAL SYSTEMS.

32 - BONE GATES.

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ASSOCIATED WITH EACH BONE, AND BEING DRIVEN BY A ~~THE~~ MSMV OF THE MSMV CHAIN, ARE A NUMBER OF ELECTRONIC GATES. THESE GATES ARE NORMALLY CLOSED, BUT ~~ARE~~ ARE OPENED BY THE RECTANGULAR WAVE FORM RECEIVED FROM THEIR DRIVING MULTIVIBRATOR. THERE IS AN OUTPUT FROM THE GATE ONLY DURING THE "OPEN" PERIOD, AND THE NATURE OR CHARACTER OF THIS OUTPUT IS A FAITHFUL REPRODUCTION OF THE GOVERNED BY THE INPUT SIGNAL. IF THE INPUT IS A D.C. SIGNAL, THEN THE OUTPUT WILL BE A CORRESPONDING D.C. SIGNAL, (SIMILARLY IF THE INPUT IS A SINE WAVE OR OTHER SHAPED SIGNAL, THE OUTPUT WILL LOOK LIKE THE INPUT.) IN OTHER WORDS, THE GATE PASSES OR ALLOWS TO PASS THRU IT ANY SIGNAL THAT IS PRESENT AT ITS INPUT DURING THE "OPEN-PERIOD" OF THE GATE.

THE GATES FOR EACH BONE ARE IN PARALLEL, AND OPERATE SIMULTANEOUSLY, AND SEND SIGNALS TO DIFFERENT PARTS OF THE DEVICE IN ORDER TO "MAKE" BONES AND CONTROL THEIR ^{VECTORS} POSITIONS IN SPACE. A GATED D.C. WAVEFORM (AS WILL BE SHOWN LATER) MAKES A STRAIGHT BONE. A GATED "SHAPED" WAVEFORM WILL MAKE A BONE ~~WHOSE~~ WHOSE AXIS IS NOT STRAIGHT, BUT HAS THE INTEGRATED, VECTATIONAL DIRECTION (OR SHAPE) PRESCRIBED BY THE SHAPED INPUT.

~~FOR BY CONTROLLING~~ VARUING THE D.C. VOLTAGE APPLIED TO THE FIRST GATE, THE ANGLE (θ) THAT THE BONE MAKES WITH THE X-AXIS OF THE DISPLAY IS VARIED. A VARIABLE POTENTIOMETER MAY BE USED TO VARY THE INPUT VOLTAGE, OR OTHER MEANS MAY BE USED, OF COURSE). THE SECOND GATE IS USED TO CONTROL THE ANGLE THAT THE BONE MAKES WITH THE X-Y PLANE, IN SIMILAR FASHION

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Lectures

By varying that D.C. input, the third gate is used to control the angular position (or may be called "rotational position") of the skin on the bone.

Additional gates may be used in similar fashion to control other parameters of the bone - such as intensity, etc., texture etc.

THE FIRST TWO GATES CALLED " Θ " AND " ϕ " SEND THEIR SIGNALS TO THE ~~AND OTHER~~ SIMILAR, ANGLE-PRODUCING NETWORKS. THESE SIGNALS MAY ALSO BE SENT TO CORRESPONDING CHANNELS OF THE TAPES RECORDER, SO THAT DURING PLAYBACK THESE MULTIPLEXED SIGNALS WILL DRIVE THE BONE AND SKIN PRODUCING MECHANISMS OF THE DEVICE, THIS AUTOMATICALLY PRODUCING THE PREVIOUSLY RECORDED MOVEMENTS OF THE BONES & ASSOCIATED PARTS.

THE OUTPUTS OF CONSECUTIVE Θ GATES ARE ALL FED INTO THE " Θ " - SINE-COSINE FUNCTION-GENERATOR AND SIMILARLY THE OUTPUTS OF ϕ GATES INTO THE ϕ SINE-COSINE FUNCTION GEN.

SINE-COSINE FUNCTION GENERATOR

See diagram 186168

THERE ARE 2 SINE-COSINE FUNCTION GENERATORS. ONE RECEIVES ITS INPUT FROM THE Θ -GATES, THE OTHER FROM THE ϕ -GATES.

EACH GENERATOR HAS 2 OUTPUTS FOR EACH INPUT. THE RANGE OF VOLTAGES AT THE INPUT REPRESENT ~~THE~~ ANY DESIRED ANGULAR POSITION OF THE BONE, AND THE TWO VOLTAGE OUTPUTS HAVE THE RELATION OF THE SINE AND COSINE RESPECTIVELY ~~OF THE~~ (SEE, GENERAL THEORY)

IN ORDER TO PRODUCE THE RELATIVE VALUES OF THE SINE AND COSINE, SAMPLES OF SINE AND COSINE WAVES ARE TAKEN AT REGULAR INTERVALS, AND THESE SAMPLES ARE FED INTO CAPACITORS WHICH HOLD THE ~~THE~~ SAMPLED VOLTAGES TO PRODUCE D.C. VOLTAGES ACROSS THE CAPACITORS WHICH ARE AT THE LEVELS BEING SAMPLED.

A ~~THE~~ SINE-COSINE FUNCTION GENERATOR HAS IN ITS NETWORK A DELAY MULTIVIBRATOR, A NARROW-OUTPUT MONOSTABLE MULTIVIBRATOR, ~~SWITCHING~~ 2 WAVE-SAMPLING GATES AND A HOLDING CAPACITOR ON THE OUTPUT OF EACH SAMPLING GATE.

THE DRIVING INPUT FROM THE COUNTER, AS STATED BEFORE IS AT $\frac{1}{2}$ THE HIGH FREQUENCY. THIS MEANS THAT THE DELAY M.V. PERFORMS ITS FUNCTION ONCE FOR EVERY 2 CYCLES OF THE HIGH FREQUENCY. THIS ALLOWS A SAMPLING OF THE SINE + COSINE WAVES TO BE TAKEN OVER 2 CYCLES OF THE WAVES, WHICH ALLOWS FOR A BONE-ANGLE SWING OF MORE THAN 360° , CONTINUOUS,

THE "DRIVING" INPUT TO THE DELAY MULTIVIBRATOR HAS TWO INPUTS. ONE INPUT COMES FROM THE 2nd STAGE OF THE COUNTER, AT $\frac{1}{2}$ THE HIGH FREQUENCY AND IS OF THE SQUARE WAVE TYPE. THIS INPUT CAUSES THE DELAY M.V. TO CHANGE STATES. IT WILL REMAIN IN THIS STATE UNTIL IT FLIPS BACK AUTOMATICALLY INTO ITS ORIGINAL STATE. THE LENGTH OF TIME THAT IT REMAINS IN THE UNSTABLE STATE IS DETERMINED BY THE 2nd INPUT, THIS 2nd INPUT (WHICH COMES FROM THE GATES) IS A D.C. VOLTAGE WHOSE VALUE DETERMINES THE LENGTH OF TIME THE DELAY M.V. WILL "DELAY".

Lee Harrison

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AND CONTROLLING INPUTS WOULD HAVE TO

THE OUTPUT OF THE DELAY MV. IS DIFFERENTIATED AND CLIPPED, SO THAT ONLY A PULSE REPRESENTING THE TRAILING EDGE OF THE CHANGE-OF-STATES IS SENT ON TO THE NARROW-PULSE MSMV.

THE INPUT TO THE NARROW PULSE MSMV IS A NARROW, TRIGGER PULSE COMING FROM THE DELAY MV. THE OUTPUT OF THE MSMV IS A VERY NARROW, STRAIGHT SIDED PULSE WHICH IS USED TO DRIVE (OR OPEN) 2 SAMPLING GATES. THE GATES ARE VERY FAST ACTING. ~~DETERMINED~~ ANOTHER INPUT TO ~~THE~~ GATES IS A SINE WAVE (TO ONE) AND A COSINE WAVE (TO THE OTHER) COMING FROM THE SINEWAVE GENERATOR (CLOCK) AND FROM THE PHASE-SHIFTER RESPECTIVELY, THUS THE OUTPUT OF THE GATES IS A VERY NARROW PULSE WHOSE HEIGHT (OR VALUE OF VOLTAGE) IS DETERMINED BY THE TIME AT WHICH THE SINE AND COSINE WAVES WERE SAMPLED, WHICH TIME WAS DETERMINED BY THE TRAILING EDGE OF THE DELAY MV., WHICH TIME WAS DETERMINED BY THE D.C. VOLTAGE IMPRESSED UPON IT, THIS VOLTAGE ~~IS~~ HAVING BEEN DETERMINED BY THE OUTPUT OF THE BONE GATES. THE NUMBER OF SUCH PULSES FOR ANY GIVEN D.C. VALUE IMPRESSED UPON THE DELAY MV. IS DETERMINED BY THE LENGTH OF ANY GIVEN BONE.

BECAUSE OF THE HOLDING CAPACITOR ASSOCIATED WITH THE OUTPUT OF EACH SAMPLING GATE, THERE APPEARS ACROSS EACH CAPACITOR A D.C. VOLTAGE ~~REPRESENTING~~ A PARTICULAR VALUE OF SINE OR COSINE, FOR A NORMAL-LENGTH BONE, THE HOLDING CAPACITOR MAY RECEIVE 15 OR 20 SAMPLING PULSES DURING THE TIME THE BONE IS BEING GENERATED.

THERE ARE OTHER WAYS OF GENERATING THIS SINE-COSINE FUNCTION, ONE SIMPLE WAY WOULD BE TO LET THE OUTPUT OF THE BONE GATES SUPPLY VOLTAGE TO ASSOCIATED SINE-COSINE POTENTIOMETERS BUT THESE POTS ARE EXPENSIVE AND *

* WOULD BE REQUIRED THAT TARGETS BE ONE FOR EACH GATE.
** WOULD BE REQUIRED EXCLUSIVELY MECHANICAL.



BONE INTEGRATORS

Lee *[Signature]* TA

#1961 DEC 29

THE INTEGRATOR IS A HIGH GAIN AMPLIFIER WHICH HAS A FEEDBACK CAPACITOR TO ITS INPUT. ITS FUNCTION IS TO PERFORM CONTINUOUS INTEGRATION OF THE SIGNALS PRESENTED TO ITS INPUT. THERE ARE THREE INTEGRATORS IN THE BONE GENERATOR, ONE FOR EACH COORDINATE (i.e. x, y, z) OF 3 DIMENSIONS. IF THE INPUT TO AN INTEGRATOR IS A D.C. VOLTAGE, THE OUTPUT IS A RAMP FUNCTION. THE INITIAL CONDITIONS (STARTING VOLTAGES ON THE OUTPUT WHICH DETERMINE THE STARTING POINT OF EACH BONE ON THE DISPLAY) ARE DETERMINED BY THE VOLTAGE ACROSS THE FEEDBACK CAPACITOR. IF THERE IS NO DISCHARGE OF THAT CAPACITOR, THEN THE BONES GENERATED BY THE INTEGRATOR ARE JOINED TOGETHER. WHENEVER THE CAPACITOR IS DISCHARGED OR "SHORTED OUT", THE INITIAL CONDITION VOLTAGES ARE MADE ZERO AND THE DISPLAY BEAM RETURNS TO A "ZERO" OR "STARTING" POSITION. (THE FLYBACK CIRCUIT TO BE DESCRIBED PERFORMS THE FUNCTION OF SHORTING OUT & DISCHARGING THE CAPACITOR AS DESIRED OR REQUIRED TO DRAW A FIGURE OR IMAGE.)

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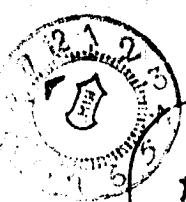
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THE VALUE OF VOLTAGE PRESENTED TO THE INPUT OF AN INTEGRATOR DETERMINES THE SLOPE (RATE OF CHANGE) OF THE OUTPUT. THE COMBINATION OF ANY TWO OF THE INTEGRATORS WHEN PRESENTED TO EACH OF THE VERTICAL AND HORIZONTAL CHANNELS OF THE CRT, WILL GIVE THE PROJECTION OF THE FIGURE (OR IMAGE BEING DRAWN) ON THE PLANE DETERMINED BY THE COMBINATION. FOR EXAMPLE, IF THE X AND Y INTEGRATOR OUTPUTS ARE USED, THEN THE DISPLAY WILL BE A VIEW WHICH IS THE PROJECTION OF THE FIGURE ON THE X, Y PLANE. SIMILARLY, IF THE Y AND Z OUTPUTS ARE USE, THE VIEW WILL BE A PROJECTION OF THE FIGURE ON THE Y, Z PLANE.

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Lee Harris

INTERMEDIATE VIEWS MAY BE OBTAINED BY COMBINING ALL THREE INTEGRATOR OUTPUTS IN PROPER ~~AMOUNTS~~ AMOUNTS; ~~THUS~~ THUS ALLOWING AN OPERATOR OF THE DEVICE TO VIEW ~~FROM~~ THE OBJECT OR FIGURE FROM ANY POSITION, THE FUNCTION OF COMBINING THESE INTEGRATOR OUTPUTS IN A PROPER FASHION IS CARRIED OUT BY THE "CAMERA ANGLE NETWORK" TO BE DISCUSSED LATER,



DEC 20 1967
D.C.

THE VALUE OF VOLTAGE PRESENTED TO THE INPUT OF AN INTEGRATOR DETERMINES THE ~~RATE~~ RATE OF CHANGE OF VOLTAGE AT THE OUTPUT, (SLOPE). IF THE ~~D.C.~~ INPUT VOLTAGES TO THE X AND Y INTEGRATORS REPRESENT THE $\cos \theta$ AND $\sin \theta$ RESPECTIVELY THEN THE OUTPUT OF THE INTEGRATORS WHEN ~~FED~~ FED INTO THE HORIZONTAL AND VERTICAL AMPLIFIERS ON A DISPLAY SCOPE WILL CAUSE THE BEAM TO DRAW A LINE ON THE SCOPE WHOSE ANGLE TO THE HORIZONTAL IS θ .

FLYBACK NETWORK.

THE FUNCTION OF THE FLYBACK NETWORK IS TO SHORT OUT OR DISCHARGE THE CAPACITORS (C) ASSOCIATED WITH THE INTEGRATORS AT DESIRED TIMES DURING EACH SEQUENCE OF BONES AND AT THE END OF EACH CYCLE OF BONE GENERATION. DISCHARGING OF THE CAPACITORS CAUSES THE BEAM OF THE DISPLAY CRT TO FLY BACK TO THE STARTING POSITION.

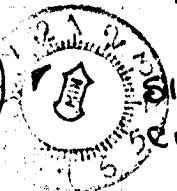
AN ELECTRONIC SWITCH DISCHARGES THE CAPACITOR. PULSES WHICH CLOSE THE SWITCH COME FROM AN AMPLIFIER WHICH IS IN TURN FED BY PULSES (WHICH ARE SELECTED AS DESIRED) COMING FROM SELECTED MULTIVIBRATORS OF THE MVB CHAIN. ALSO, A PULSE WHOSE DURATION IS DETERMINED BY THE TIME OF THE LAST MSMV TO THE BEGINNING OF A NEW CYCLE OF THE FIRST MSMV IS GENERATED BY A BI-STABLE MULTIVIBRATOR. THIS FLYBACK BI-STABLE MV RECEIVES A PULSE FROM THE LAST MSMV AS IT CLOSES. THIS PULSE FLIPS THE BSMV AND ITS OUTPUT CAUSES THE SWITCHES TO CLOSE. THIS BSMV STAYS IN THE "CLOSED" STATE UNTIL IT RECEIVES ANOTHER INPUT PULSE WHICH THIS TIME COMES FROM THE ~~COUNTER~~ COUNTER, THE SAME PULSE WHICH STARTS THE CHAIN OF MSMV'S.

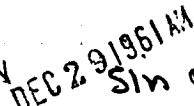
DIODES CONNECT ALL OF THE PULSE INPUTS TO THE AMPLIFIER WHICH ACTIVATES THE SWITCHES SO AS TO PREVENT PULSES FROM FEEDING BACK INTO THE GATES AND THUS ^{CAUSING THEM TO} OPERATE OUT OF SEQUENCE.

THE ELECTRONIC SWITCHES REMAIN CLOSED DURING THE DURATION OF A PULSE, ~~BE IT LONG OR SHORT.~~

SKIN NETWORK.

THE FUNCTION OF THE SKIN NETWORK IS TO ALGEBRAICALLY COMBINE THE VARIOUS VOLTAGE REPRESENTATIONS OF $\sin \theta$, $\cos \theta$, $\sin \phi$, $\cos \phi$, $k_i t_x$, $k_i t_y$, $k_i t_z$, $\sin k_2 t$ AND THE VIDEO SIGNAL "A", TO GIVE THE PROPER FORMULAMATIC REPRESENTATIONS OF THE GEOMETRIC PROJECTIONS OF THE FIGURE OR OBJECT BEING GENERATED. FOR QUICK REFERENCE, A TABULAR EXPLANATION OF THESE VARIOUS SIGNALS IS GIVEN BELOW.

$k_i t_x$ } $\sin \theta$: } D.C. VALUES OF VOLTAGE WHOSE RELATIONSHIP

 $\cos \theta$: } IS AS THE SINE AND COSINE OF THE ANGLE θ

$k_i t_y$ } $\sin \phi$: } D.C. VALUES OF VOLTAGE WHOSE RELATIONSHIP

 $\cos \phi$: } IS AS THE SINE AND COSINE OF THE ANGLE ϕ .

$k_i t_x$ } RAMP FUNCTIONS OF VOLTAGE, THE OUTPUTS
 $k_i t_y$ } OF INTEGRATORS X, Y AND Z RESPECTIVELY,
 $k_i t_z$ } WHERE THE CONSTANT K_i IS A SCALING
 FACTOR, WHICH IS A DEVICE FUNCTION OF THE
 GAINS OF DISPLAY AMPLIFIERS OF THE GAINS OF THE INTEGRATING
 AMPLIFIERS AND ALSO A FUNCTION OF THE AMPLITUDE OF THE
 INPUT SINE AND COSINE WAVES TO THE INTEGRATORS. FOR
 SIMPLICITY THESE EFFECTS ARE ACCOUNTED FOR BY THE USE
 OF THIS "LUMPED CONSTANT" K_i.

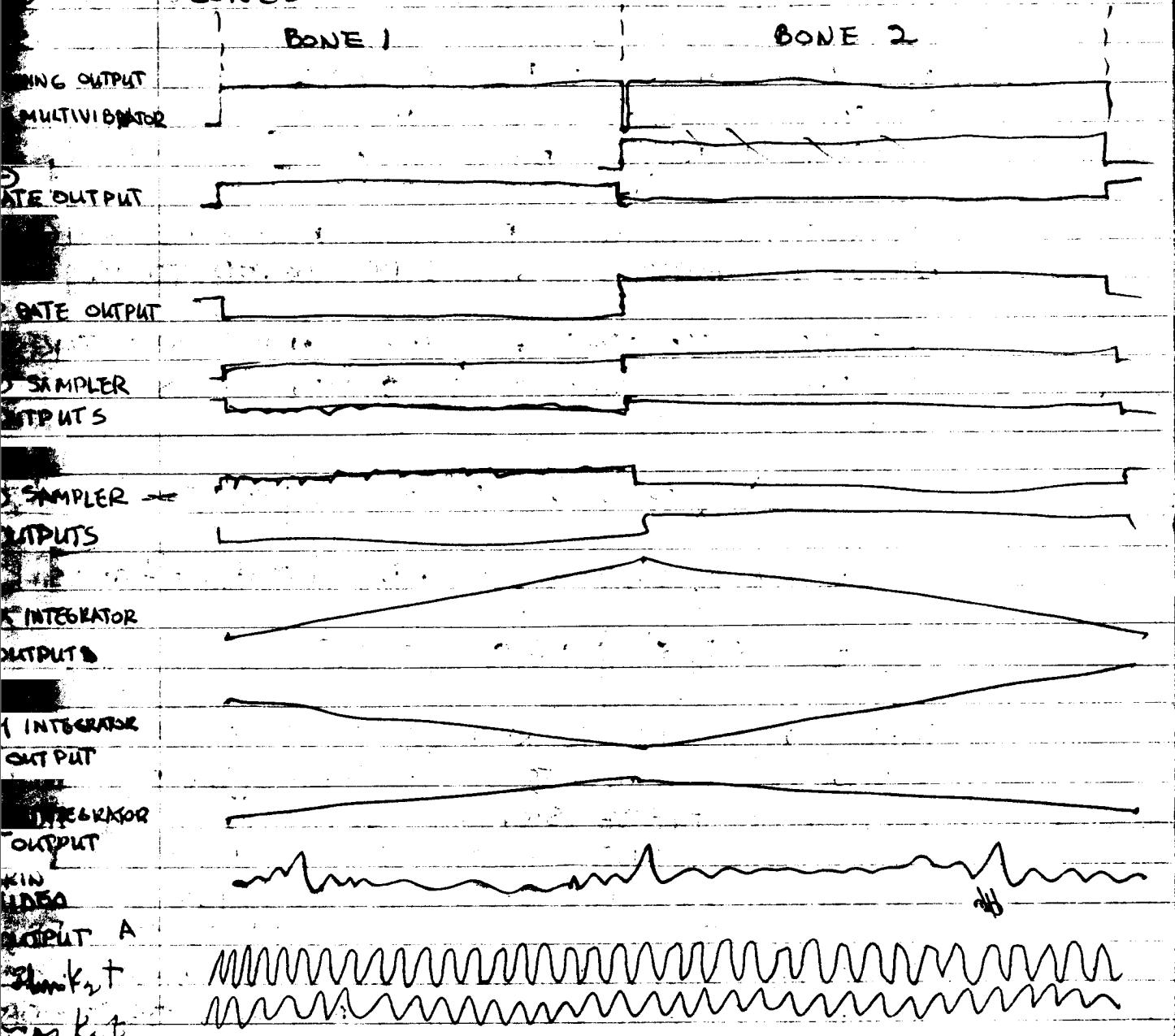
$\sin k_2 t$: } SINE AND COSINE WAVE FUNCTIONS
 $\cos k_2 t$: } WHOSE FREQUENCY (THE HIGH FREQUENCY)
 IS DETERMINED BY K₂, AND WHOSE
 AMPLITUDE IS CONSIDERED TO BE EQUAL
 TO 1 (ONE UNIT), (FOR A NORMAL MATHEMATICAL
 REPRESENTATION WE'D HAVE TO USE " $a \sin k_2 t$ " TO
 DENOTE THIS WAVE, BUT WE SIMPLIFY THE EXPRESSION
 BY LETTING $a = 1$ unit, which means about 10 volts p-p)

Lee Karmen MB

A : }

CAPITAL A IS USED TO DENOTE THE VIDEO SIGNAL WHICH COMES FROM THE SKIN SCANNER. THIS IS A WIDE BAND SIGNAL WHOSE UPPER FREQUENCIES ARE VERY HIGH.

TO SHOW THE INTER-RELATIONSHIP OF THE VARIOUS SIGNALS, A PICTOGRAPH IS GIVEN BELOW FOR 2 BONES



Lee Harwood

TWO ALGEBRAIC FUNCTIONS ARE PERFORMED BY THE PORTION OF THE DEVICE WHICH WE CALL THE SKIN NETWORK, NAMELY MULTIPLICATION AND ADDITION.

ASSOCIATED WITH EACH MULTIPLIER ~~ARE~~ ARE INPUT AND OUTPUT AMPLIFIERS, WHICH ARE ELECTRONICALLY NECESSARY TO ALLOW AN ANALOGUE MULTIPLIER TO PERFORM THE TASK OF MULTIPLICATION. ~~SEPARATELY~~

~~THE~~ MULTIPLIERS REQUIRE A "CENTER TAP" INPUT, THUS ~~THE~~ THE THREE INPUTS TO ~~THE~~ MULTIPLIERS. ~~SEPARATELY~~

THE IMPORTANT THING HERE IS NOT HOW WE PERFORM THE PARTICULAR TASK, BUT THAT WE DO PERFORM IT.

ADDERS ARE MERELY RESISTOR NETWORKS WHICH ADD THE VARIOUS SIGNALS PRESENTED TO IT.

ALGEBRAICALLY SPEAKING, THE SKIN NETWORK TAKES THE PREVIOUSLY MENTIONED SIGNALS AND COMBINES THEM SO THAT

$$x = k_x t_x \cos \theta \cos \phi + A \cos \theta \sin \phi \cos k_2 t - A \sin \theta \sin k_2 t$$

$$y = k_y t_y \sin \theta \cos \phi + A \sin \theta \sin \phi \cos k_2 t + A \cos \theta \sin k_2 t$$

$$z = k_z t_z \sin \phi + A \cos \phi \cos k_2 t$$

HERE, X, Y AND Z REPRESENT THE X, Y AND Z VECTORIAL COMPONENTS OF THE FIGURE. BY PRESENTING ANY 2 OF THESE SIGNALS TO THE X AND Y CHANNELS OF A DISPLAY CRT, THE RESULTING DRAWING WILL BE A PROJECTION OF THE 3 DIMENSIONAL FIGURE ON THE PLANE DETERMINED BY THE COMPONENTS SELECTED, BY THE GEOMETRIC SELECTION AND COMBINATION OF ALL THREE OF THESE COMPONENTS, ANY VIEW ~~OR~~ OR PROJECTION OF THE 3 DIMENSIONAL FIGURE MAY BE SHOWN

CAMERA-ANGLE NETWORK

THE FUNCTION OF THE CAMERA ANGLE NETWORK IS TO ALGEBRAICALLY (AND THUS GEOMETRICALLY) COMBINE THE X, Y, AND Z COMPONENTS OF THE THREE DIMENSIONAL FIGURE IN SUCH A MANNER AS TO ALLOW FOR THE PRESENTATION OF ANY ²₁ PROJECTION OR VIEW OF THE FIGURE WHEN THE ²₁ OUTPUTS OF THIS NETWORK ARE PRESENTED TO THE X AND Y CHANNELS OF A DISPLAY CRT.

2 ALGEBRAIC FUNCTIONS ARE PERFORMED: THE FIRST IS MULTIPLICATION BY A CONSTANT, THE SECOND IS ADDITION.

THE "MULTIPLICATION BY A CONSTANT" IS, IN EFFECT THE "TAKING OF THE SINE AND COSINE" OF THE VECTOR AND IS ACCOMPLISHED BY A NETWORK OF VARIABLE "SINE-COSINE" POTENTIOMETERS. ADDITION IS PERFORMED USING A FIXED RESISTANCE NETWORK.

ANGLES Θ' (THETA PRIME) AND ϕ' (PHI PRIME) REPRESENT THE ROTATION OF THE XY PLANE ABOUT THE X AXIS AND THE XZ PLANE ABOUT THE Z AXIS.

2 SIN-COSINE POTS GANGED TOGETHER (ON A COMMON SHAFT) IS THE MECHANISM FOR PERFORMING THE PROPERLY-RELATED MULTIPLICATION BY CONSTANTS, TAKING THE SINES & COSINES IN THE PROPER RELATIONSHIP.

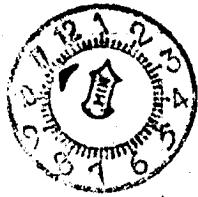
THERE ARE TWO SUCH MECHANISMS. ROTATION OF THE SHAFT OF ONE, CONTROLS THE VIEWING ANGLE Θ' . THE OTHER CONTROLS ϕ' . AMPLIFIERS ASSOCIATED WITH THE NETWORK OF SINE-COSINE POTS ARE AN ELECTRONIC NECESSITY.

THE TWO OUTPUTS OF THIS NETWORK ARE FED INTO THE X AND Y CHANNELS OF THE DISPLAY CRT, AND REPRESENT THE BEAM-POSITIONAL INFORMATION NECESSARY TO DRAW THE FIGURE.

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SWKarmen III

EVENTUALLY, WE'LL USE CONTROLLING SERVO-MOTORS TO POSITION THE SHAFTS θ + ϕ , SO THAT THE CAMERA ANGLES MAY BE RECORDED ON THE CONTROL-TAPE RECORDER ALONG WITH OTHER CONTROLLING INFORMATION. IN OTHER WORDS, WE'LL RECORD SIGNALS TO WHICH THE SERVOS WILL REACT, THUS RECORDING THE CAMERA ANGLES.



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SKIN GENERATOR.

THE FUNCTION OF THE SKIN GENERATOR IS TO GENERATE A VIDEO SIGNAL, THE MAGNITUDE OF WHICH REPRESENTS THE DISTANCE (OR THICKNESS) BETWEEN THE BONE (VECTOR) AND THE SURFACE (OR SKIN) OF THE OBJECT OR FIGURE BEING DRAWN.

THE SKIN GENERATOR IS A FLYING SPOT SCANNER WHICH SCANS A SPECIALLY PREPARED PHOTOGRAPH, THE DENSITY OF WHICH CONTAINS THE DESIRED "THICKNESS" INFORMATION.

GENERAL } THE SKIN GENERATOR IS A HIGH SPEED COMMUTATOR WHICH CONVEYS IN PROPER SEQUENCE, ^{AND SYNCHRONIZATION} THE THICKNESS INFORMATION OF ~~THE OBJECT~~ WHICH IS RETAINED IN A CONVENIENT FORM OF ~~MEMORY DEVICES~~, INFORMATION STORAGE DEVICE OR MEDIUM.

THE FLYING SPOT SCANNER IS ~~AN~~ A SPECIAL (SHORT PERSISTENCE) CATHODE RAY TUBE IN WHICH THE BEAM SWEEPS OUT A PRESCRIBED RASTER (PATTERN OF LINES), THE BEAM PRODUCES A SHORT PERSISTENCE SPOT OF LIGHT ON THE FACE OF THE TUBE. THIS SPOT OF LIGHT IS OPTICALLY CONDUCTED AND FOCUSED ON THE PHOTOGRAPHIC TRANSPARENCY WHICH TRANSMITS VARYING AMOUNTS OF LIGHT ACCORDING TO THE FILM DENSITY, THUS THE PHOTOGRAPHIC TRANSPARENCY MODULATES THE INTENSITY OF THE LIGHT, AS THE SPOT SWEEPS OR SCANS ACROSS IT. THIS MODULATED LIGHT IS COLLECTED BY A CONDENSING LENS AND ROUGHLY FOCUSED ON A PHOTO-MULTIPLIER TUBE WHICH CONVERTS THE MODULATED LIGHT INTO A VOLTAGE SIGNAL (VIDEO). (IN GENERAL THIS SYSTEM ACTS AS A HIGH SPEED COMMUTATOR, COMMUTATING MANY PIECES OF INFORMATION IN THE DESIRED STREAM)

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Lee Garrison

OR SEQUENCE.)

THE VIDEO SIGNAL IS THEN ADDED (VECTORIALLY SPEAKING) TO THE BONE SIGNAL, GIVING THE POSITIONAL INFORMATION TO THE DISPLAY BEAM WHICH REPRESENTS THE THICKNESS OF THE OBJECT OR FIGURE BEING DRAWN.

THE MOVEMENT OF THE FLYING SPOT IS CONTROLLED BY DEFLECTION AMPLIFIERS IN SCANNER. THE CONTROLLING DEFLECTION WAVE FORMS ARE GENERATED HORIZONTAL AND VERTICAL IN THE DEFLECTION GENERATORS ^{SAW TOOTH GENERATORS} ~~WHICH INPUT COMES FROM THE CLOCK~~, WHICH ARE SYNCHRONIZED AND DRIVEN BY AN INPUT FROM THE CLOCK

THE RASTER PATTERN OF MOVEMENT OF THE SPOT) OF THE SCANNER IS ~~IS~~ BASICALLY RECTANGULAR, WITH SOME LOCALIZED MODIFICATIONS IN THE PATTERN FOR SPECIAL, SKIN-DISTORTION EFFECTS AS IN LIP, EYE & OTHER FACIAL ~~MATERIALS~~ AND PLASTIC-TYPE MOVEMENTS, (SUCH AS WRINKLE EFFECTS WHICH WOULD BE AUTOMATICALLY DEVELOPED AS A FUNCTION OF ^{ASSOCIATED} BONE ANGLES.)

DEC 29 1961 THE SKIN GENERATOR MAY ALSO BE USED TO DEVELOP OTHER SKIN INFORMATION SUCH AS COLOR, TEXTURE & SHADING, (THIS WILL BE DISCUSSED LATER.)

Lectures on M

Recording Network & Tape Recorder

The function of the RECORDING NETWORK is to record the joined-together gate output signals (multiplexed single-signal) and allow for the play-back of these signals.

The recorder is a multi-channelled recorder. On one channel is recorded the CLOCK & FRAME SIGNALS AND FOR SYNCHRONIZATION. Sound is recorded on another

SELECTIVE RECORDING OF INDIVIDUAL GATE-OUTPUTS

OR GROUPS OF GATE-OUTPUTS IS ACCOMPLISHED WITH RECORDING GATES WHICH ARE ACTIVATED (OPENED)

BY THE MULTIVIBRATORS ASSOCIATED WITH THE BONE GATES DESIRED TO BE RECORDED. A SWITCH

MAY BE EMPLOYED TO HOLD THESE RECORDING GATES OPENED IF IT IS DESIRED TO RECORD ALL OF

THE BONES, (AS AN OPERATOR MAY DO AT THE BEGINNING OF AN "INJECTION RUN")

~~THE TAPE MOVES ACROSS THE WRITE HEADS ARE~~

~~ON THE TAPE RECORDER FIRST, THEN ON TO THE TAPE~~ SITUATED "UPSTREAM" FROM THE "READ HEADS" (PLAYBACK)

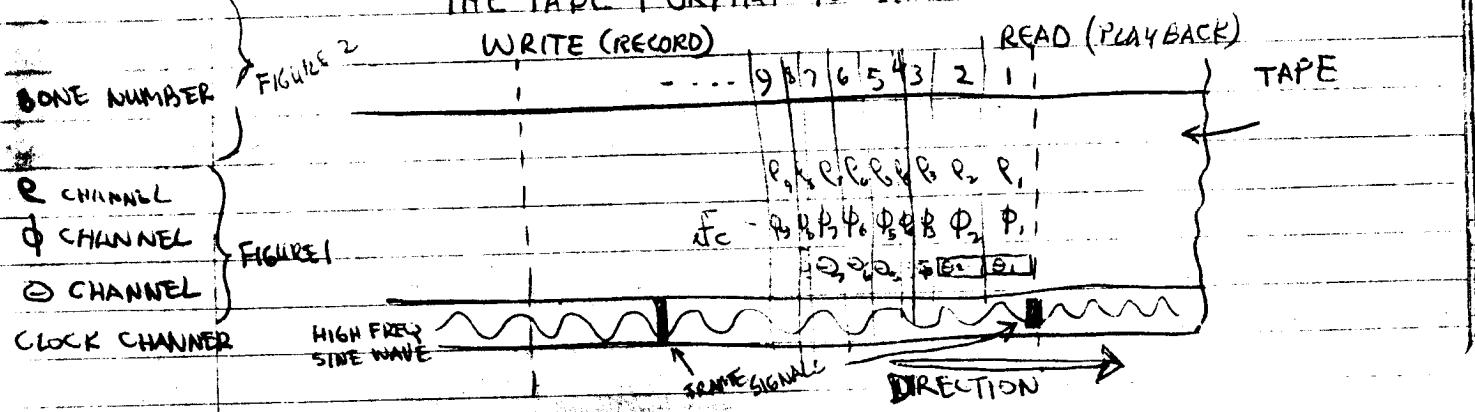
AS FAR AS TAPE MOTION IS CONCERNED, THE SIGNALS WHICH ARE PASSED BY THE RECORDING GATES ARE,

THENCE RECORDED ON THE TAPE BY THE WRITE HEADS.

THE SIGNALS THUS RECORDED ARE ALMOST IMMEDIATELY READ BY THE "READ" HEADS ~~FROM WHICH~~ WHICH THE SIGNALS ARE AMPLIFIED AND SENT INTO THE

BONE GENERATION NETWORK,

THE TAPE FORMAT IS SHOWN BELOW



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Luffmann M

THE CLOCK CHANNEL HAS RECORDED ON IT THE HIGH FREQUENCY SINE WAVE PLUS THE INTERMITTENT FRAME PULSE. THESE SIGNALS ARE SEPARATED ^{ELECTRONICALLY} AFTER READING, AND THE SINE WAVES ARE SENT TO THE BONE GENERATOR & THE FRAME PULSES ARE SENT TO THE COUNTER CHAIN.

AFTER THE Θ AND ϕ CHANNELS ARE FILLED WITH RECORDED SIGNALS, SELECTIVE RE-RECORDING IS ACCOMPLISHED BY MAKING CONNECTIONS BETWEEN ~~THE~~ SELECTED MSMV's & THE RECORDING GATES, SO THAT THE ^{THESE} GATES ARE OPENED ONLY DURING THE TIMES OF OCCURRENCE OF THE OPENING OF THE ~~ASSOCIATED~~ $\Theta + \phi$ GATES ASSOCIATED WITH THE SELECTED MSMV's, (THE INITIAL RECORDING SWITH IS OPENED,

FOR EXAMPLE, SUPPOSE AN OPERATOR WISHED TO RE-RECORD THE ANGULAR ACTIONS OF THE 4th + 5th BONES. HE'D CONNECT THE PULSED OUTPUT OF MSMV's # 4 + 5 TO THE ~~RECORDING GATE~~ ACTUATING INPUT TERMINAL OF THE RECORDING GATE, THUS THE ONLY TIME RECORDING WOULD TAKE PLACE WOULD BE AT THE EXACT SPOTS ON THE TAPE THAT CORRESPONDED TO THE PREVIOUSLY RECORDED ACTIONS OF BONES 4 + 5, THE WRITE HEAD IN BEING ACTIVATED AT THOSE TIMES WOULD OBLITERATE THE PREVIOUSLY RECORDED SIGNALS AND LEAVE THE NEWLY DESIRED SIGNALS ON THE TAPE, THE REST OF THE ^{FRAME} TIME, THE RECORDING GATES ARE CLOSED.

~~THE~~ THE READ HEADS PICK UP THE OLD AS WELL AS THE NEW SIGNALS, AND TRANSMIT THEM THROUGH THE DEVICE TO STIMULATE THE DESIRED ~~ACTION~~ ACTION ON THE DISPLAY.

OTHER TAPE CHANNELS ARE USED IN SIMILAR FASHION TO ~~CONT~~ RECORD AND CONTROL OTHER PARAMETERS OF THE BONE. FOR EXAMPLE, THE ρ (RHO) CHANNEL IS USED TO CONTROL THE ROTATIONAL POSITION (OR TWIST) *

RECORDED AT 1511 AM
DECEMBER 9 1961

THE
OF
*

CONTROLS

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Refugee (A)

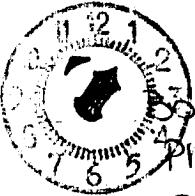
CONTROL OF MOTION & OTHER PARAMETERS

~~OF THE SKIN RELATED TO THE BONES AND~~

BY CONTROLLING THE VOLTAGE INPUTS TO THE BONE GATES, THE POSITIONS, ATTITUDES, PLASTIC DISTORTIONS AND OTHER SPACIAL PARAMETERS ARE CONTROLLED. THE FUNCTION OF THE CONTROLLER IS TO GENERATE THE DESIRED SIGNALS FOR THE VARIOUS MOTIONS. IN GENERAL, THE CONTROLLING SIGNALS ARE VERY LOW FREQUENCY - in some cases practically D.C. (THE SAMPLING RATE FOR EACH BONE SIGNAL TO BE MULTIPLEXED IS 24 TIMES PER SECOND. IN ONE SECOND, UNLESS THE ACTION OF A BONE IS VERY SWIFT, THE VOLTAGE VARIATION FROM THE BEGINNING TO THE END OF ONE DRAWING CYCLE ($\frac{1}{30}$ sec) OF ONE BONE ($\approx \frac{1}{30} (\frac{1}{24}) \approx \frac{1}{720}$ sec) IS VERY SLIGHT. THAT IS TO SAY, SUPPOSE THE VOLTAGE VARIES $\frac{1}{10}$ VOLTS IN ONE SECOND DUE TO THE TURNING OF A POTENTIOMETER, THEN THE VARIATION FROM THE BEGINNING TO THE END OF A BONE IS ABOUT $\frac{1}{720}$ VOLTS WHICH IS SUCH A SMALL CHANGE THAT THE BONE APPEARS STRAIGHT.)

NETWORKS OF VARIABLE RESISTORS AND VERY LOW-FREQUENCY GENERATORS MAY BE USED TO GENERATE INTERRELATED BONE-GROUP ACTIONS OR MOTIONS. AS THE MANIPULATION OF THE POTENTIOMETER INPUTS IS SIMPLIFIED, IT MAY BE CONSIDERED THAT THE "CONTROLS" MAY BECOME MORE AND MORE COMPUTER-LIKE, WHERE MANY BONE MOTION FUNCTIONS ARE GENERATED AUTOMATICALLY.

SHAPED WAVEFORMS OTHER THAN STRAIGHT BONES MAY BE PRODUCED BY FEEDING SHAPED WAVEFORMS (SAWTOOTH, SINE, ETC.) AT HIGHER FREQUENCIES INTO THE BONE GATES. SHAPED WAVEFORMS IN PLACE OF D.C. INPUTS WILL GIVE BONES OTHER THAN STRAIGHT. FOR EXAMPLE A SAWTOOTH CONTROL INPUT WILL MAKE A WIGGLY 



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Ledhamo *SM*

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BONE; A SINEOIDAL INPUT (IF AT THE PROPER PHASE & FREQUENCY) WILL MAKE A CIRCULAR BONE; A ~~SINE~~ SQUARE (TYPE) WAVE INPUT WILL MAKE A ZIG ZAG ~ OR SAWTOOTH TYPE BONE; A RAMP INPUT TO THE BONE GATES WILL MAKE A CURVED OR ARCHED BONE.

SPECIAL ^{CONTROLLING} WAVEFORMS MAY ALSO BE INSERTED either BEFORE OR AFTER THE INTEGRATOR, WITHOUT PASSING THROUGH THE ^{SUBGATING AND} SAMPLING NETWORKS. IN ORDER TO PRODUCE DESIRED MUTATIONS ON THE BONES (TECHNIQUES SUCH AS THESE HAVE BEEN DISCUSSED ON MANY OCCASIONS AND WILL BE EXCELTED WHEN TIME ALLOWS) *JSS-8*

JOY-STICKS & FINGER CONTROLS HAVE BEEN DESIGNED FOR EASY, MECHANICAL MANIPULATION OF THE CONTROLS & MAY BE THE SUBJECTS OF LATER PATENTS. SPECIAL ^{CONTROLLING} INPUTS FOR FACIAL EXPRESSIONS MAY BE ~~THESE TECHNIQUES INC~~ TRANSDUCED FROM ACTUAL FACIAL & LIP MOTIONS USING A NETWORK OF STRAIN GAGES

SHADING (AND COLOR) NETWORK

Lecture notes

12/29/61

THE ELECTRONIC SIGNALS COMING OUT OF THE CAMERA ANGLE NETWORK ARE BEAM POSITIONING SIGNALS; (just as FINGERS CONTROL THE POSITION OF A PENCIL ON PAPER). THE FUNCTION OF THE SHADING (AND COLOR) NETWORK IS TO GOVERN THE BEAM INTENSITY AS IT DRAWS THE FIGURE OR OBJECT. ~~AND IS CONCERNED WITH THE LINE SPEED~~ (HIGH FREQUENCY) VARIATIONS IN INTENSITY ASSOCIATED WITH SKIN SHADES & SHADOWS, TEXTURES etc, WHICH ARISE FROM THE SURFACE VARIATIONS IN THE SKIN. (COLOR VARIATIONS IN THIS SENSE ARE THOUGHT OF IN TERMS OF A THREE-COLOR (MULTI-COLOR) PROCESS WHERE FOR EXAMPLE THE IMAGES OF ~~THE~~ ^(IMAGES IDENTICAL ON EACH) THREE DISPLAY SCOPES, ARE OPTICALLY SUPERIMPOSED, AND EACH SCOPE HAS A COLOR FILTER ON ITS FACE. BY VARYING THE INTENSITIES OF THE 3 BEAMS, THE ~~SCOPE~~ OPTICAL IMAGE HAS FULL SPECTRUM COLOR CAPABILITY. ^{TWO OR} THUS THIS TOPIC IS CALLED "SHADING (AND) COLOR NETWORK.)

THE "SKIN" VIDEO SIGNAL CONTAINS THE INFORMATION ABOUT THE ~~CONTINUOUS DISTANCE~~ (THICKNESS) ORTHAGONAL DISTANCE BETWEEN BONE AND SKIN. IN THE FULL BASIC FORMAT, THE RATE OF CHANGE OF THE VIDEO SIGNAL IS USED TO ^{THE BRIGHTNESS (SHADING)} CONTROL HIGH FREQUENCY SKIN VARIATIONS TO ACCENTUATE ~~SKIN~~ SKIN FEATURES WHICH OCCUR BETWEEN THE EDGES OF THE OBJECT BEING DRAWN IN THIS FORMAT. BY DIFFERENTIATING THE SKIN VIDEO A RATE-OF-CHANGE SIGNAL IS OBTAINED. A THRESHOLD NETWORK DETECTS ALL RATES ^{OF CHANGES} ABOVE ~~ON~~ A PRESCRIBED ABSOLUTE VALUE. THE CLIPPED OUTPUT OF THE THRESHOLD NETWORK IS AMPLIFIED AND SCALED, thence used to modulate beam intensity.

ROUNDING, EDGE EFFECTS (^{EDGE} SHADOWS etc)

ARE PRODUCED IN ACCORDANCE WITH THE SKIN/VECTOR POSITION WHICH IS A FUNCTION OF THE PHASE OF THE HIGH FREQUENCY SINE WAVE FROM THE CLOCK.

IN ADDITION, A HIGH FREQUENCY WOBBLE OR A FOCUS-FLARE MAY BE EMPLOYED TO HEAVY-UP OR THICKEN THE EDGES, THIS ACTION ALSO BEING ~~ASYNCHRONOUS~~ SYNCHRONOUS WITH PHASE OF THE HIGH FREQUENCY SINE WAVE.

~~DO NOT VARY WITH FLAT COLOR EFFECTS, OR GRAYS OR TEXTURES WHICH~~
~~BONE POSITION~~, MAY BE PRODUCED BY GATING IN THESE INTENSITY MODULATING SIGNALS ~~USING~~ ~~IN CONJUNCTION WITH~~ THE BONE GATES DESIGNED FOR THAT PURPOSE. THE INPUT TO THE GATES ~~MAY BE~~ A HIGH FREQUENCY OF A CERTAIN PATTERN WHICH WHEN APPLIED TO MODULATE THE BEAM INTENSITY DURING THE DRAWING OF A PARTICULAR BONE WILL GIVE A TEXTURED PATTERN. MORE SPECIFICALLY, VIDEO SIGNALS ~~CONTAINING DESIGNS~~ OF PRESCRIBED DESIGNS MAY BE APPLIED IN THIS MANNER TO GIVE THE ~~THE~~ DESIRED EXTERIOR APPEARANCE OF AN OBJECT ~~BONE~~ PART AS A SOAP BOX OR OTHER CONSUMER PRODUCT, OR A SHIRT PATTERN (ON A ^{HUMAN} FIGURE) OR A FUR PATTERN (ON AN ANIMAL CHARACTER) (TO GENERATE THIS INTENSITY VIDEO, ANOTHER SCANNER WOULD BE REQUIRED, OR A SPLIT-IMAGE SCANNING TECHNIQUE WHERE OPTICAL MEANS, ARE USED TO HAVE THE SKIN-SCANNING RASTER OF THE FLYING SPOT FOCUSED ON TWO (OR MORE) FILMS - WHERE ONE FILM CONTAINS THICKNESS INFORMATION AND ANOTHER CONTAINS SURFACE COLOR, PATTERN OR TEXTURE INFORMATION.

OVERLAP PREVENTION AND SCAN CONVERSION

BECAUSE THE DISPLAY BEAM IS DRAWING A 2-DIMENSIONAL PROJECTION OF A 3-DIMENSIONAL IMAGE IN A CONTINUOUS MANNER IT IS NECESSARY TO PROVIDE A MEANS OF PREVENTING THE BEAM FROM DRAWING OVER A PORTION OF THE IMAGE WHICH HAS ALREADY BEEN DRAWN. THIS A SPECIAL DEVICE FOR "OVERLAP PREVENTION" HAS THE FUNCTION OF DOING AWAY WITH "GHOST" IMAGE OR ~~OR~~ OVERLAP.

OVERLAP MAY BE ~~SPLITTED~~ ~~INTO~~ CLASSIFIED ~~INTO~~ TWO TYPES. ONE TYPE OCCURS WHEN THE "BACK PART" OR PART OF THE IMAGE ON THE SIDE AWAY FROM THE VIEWER IS DRAWN. THIS OVERLAP IS PREVENTED BY TURNING OFF THE INTENSITY OF THE BEAM ACCORDING TO THE VECTORIAL POSITION OF THE SKIN VECTOR WHICH IS A FUNCTION OF 1) PHASE OF THE HIGH FREQUENCY, AND 2) THE CAMERA ANGLE (WHICH GOVERNS THE POSITION OF THE PLANE OF PROJECTION).

THE 2nd TYPE OF OVERLAP OCCURS WHEN ONE PART OF AN OBJECT OR FIGURE OVERLAPS ANOTHER PART, OR WHERE ONE FIGURE IS IN FRONT OF ANOTHER. BY USING A SPECIAL DISPLAY TUBE WHICH HAS IN IT, TWO OR MORE ELECTRON GUNS, ONE OF WHICH IS A "WRITE" GUN, ANOTHER OF WHICH IS AN "ERASE" GUN (HAVING SELECTIVE ERASURE CAPABILITY) AND HAVING THE ERASE GUN PRECEDE THE WRITE GUN BY EMPLOYING A SLIGHT DELAY IN THE "WRITE" SIGNALS (BOTH GUNS GETTING THE SAME ^{POSITIONAL} DISPLAY SIGNALS HOWEVER) OVERLAP MAY BE PREVENTED, AS LONG AS THE ~~DISPLAY~~ OBJECT OR PART OF THE OBJECT WHICH IS TO BE DISPLAYED IS DRAWN IN THE ~~LAST~~ SEQUENCE COMPATIBLE WITH THIS METHOD (NAMELY, LAST

~~See Harrison~~

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A MULTI-GUN SCOPE THIS EMPLOYED WILL CONTAIN THE IMAGE THUS DRAWN FOR A LENGTH OF TIME ~~NOT~~ NECESSARY FOR PHOTOGRAPHING OR SCAN CONVERTING. A SCAN CONVERSION TUBE MAY BE USED TO ~~TRANSFORM~~ THE ~~NOT~~ DRAWN IMAGE INTO A SCANNING PATTERN WHICH IS COMPATIBLE WITH TELEVISION TRANSMISSION OR A CLOSE-LINE RASTER WHICH WOULD BE COMPATIBLE FOR THE SUPERPOSITION OF FIGURES ON A BACKGROUND.

AT THIS POINT IN THE GENERATION OF ANIMATED PICTURES IT IS NECESSARY TO CONSIDER PICTURE QUALITY IN TERMS OF RESOLUTION. THE PROBLEM OF RESOLUTION BECOMES ACUTE WHEN HIGH ~~SPEED~~ SCANNING SPEED CAUSES NECESSITATES HIGH BANDWIDTH REQUIREMENTS. THUS IT IS CONTEMPLATED THAT THE SPECIAL PICTURE TECHNIQUES (SUPERIMPOSITION-OVERLAP PREVENTION-SCAN CONVERSION) WILL BE CARRIED ON AT A RELATIVELY SLOW RATE - i.e. NOT AT THE SAME SPEED AT WHICH WE ANIMATE. AN OPERATOR MAY DO HIS ANIMATION ~~NOT~~ IN REAL TIME (WHERE THE DEVICE ~~DOES~~ PUTS THE ^{CONTROL} SIGNALS INTO A 24/FRAME/SEC FORMAT) BUT THE EVENTUAL FILM-RECORDING OF THE ANIMATED SEQUENCES WILL BE AT A SLOWER RATE, AND OF COURSE ALL AUTOMATICALLY CONTROLLED BY THE PRE-PROGRAMMED ANIMATION WITH LOW, REPRODUCTION-SCANNING RATES, HIGH RESOLUTION (COMPATIBLE WITH 35MM FILM GRAIN) MAY BE ATTAINED,